

Expert Forum DeburringEXPO 2023

Processing of internal surfaces by AFM (Abrasive Flow Machining)



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- **Company Profile of 4MI GmbH**
- **Process Abrasive Flow Machining (AFM)**
- **Machine**
- **Media**
- **Fixture**
- **Cleaning**
- **Subcontracting**
- **Applications / Industries / Branches**

Company Profile of 4MI GmbH

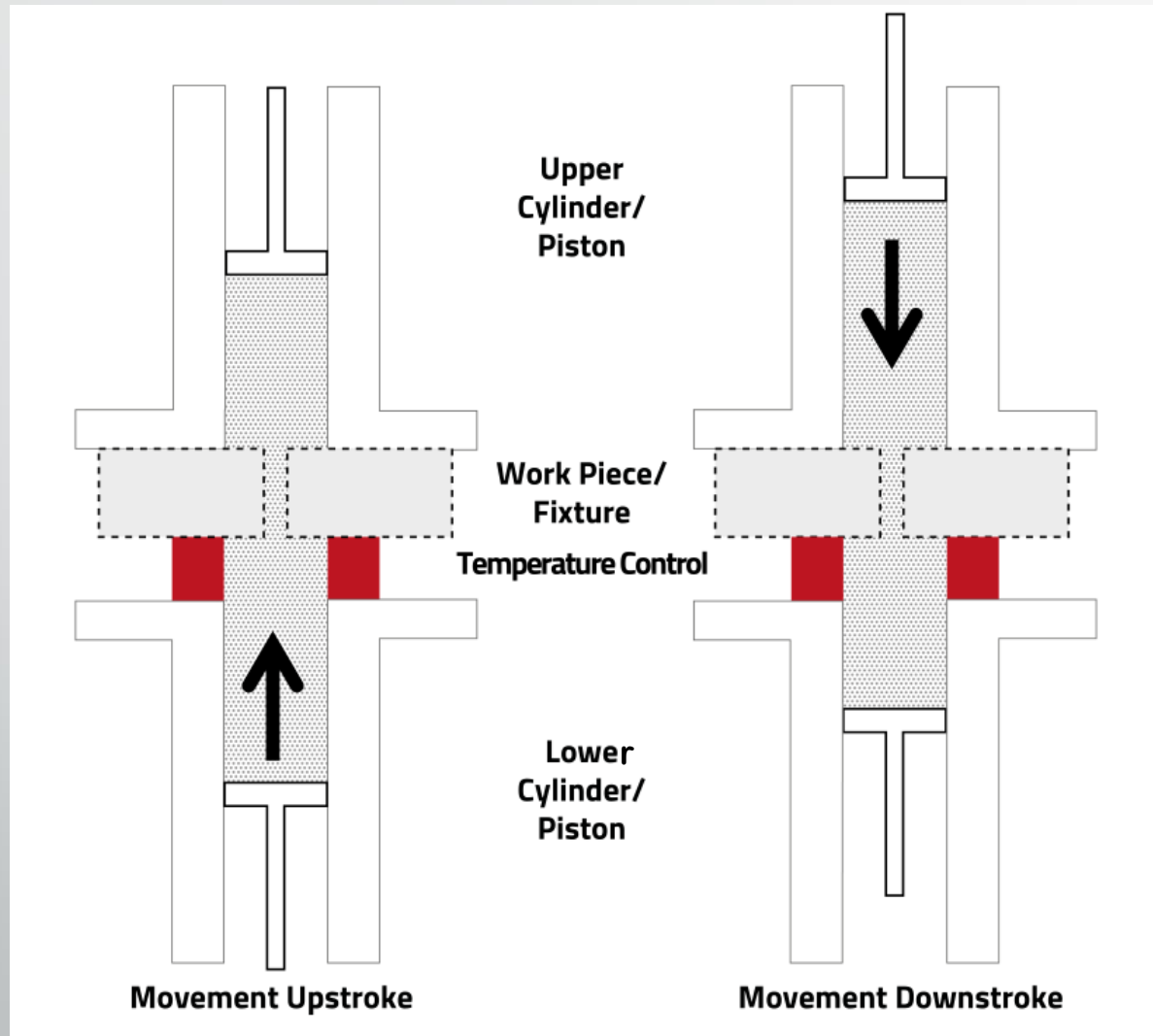
- **Founded 2015**
- **Headquarters in Malsburg-Marzell (Germany)**
- **Technical center in Ludwigsburg near Stuttgart**
- **Core Competency: Processing of inner surfaces by Abrasive Flow Machining (AFM)**
- **Our team has decades of experience in AFM**
- **Certified to ISO9001:2015**



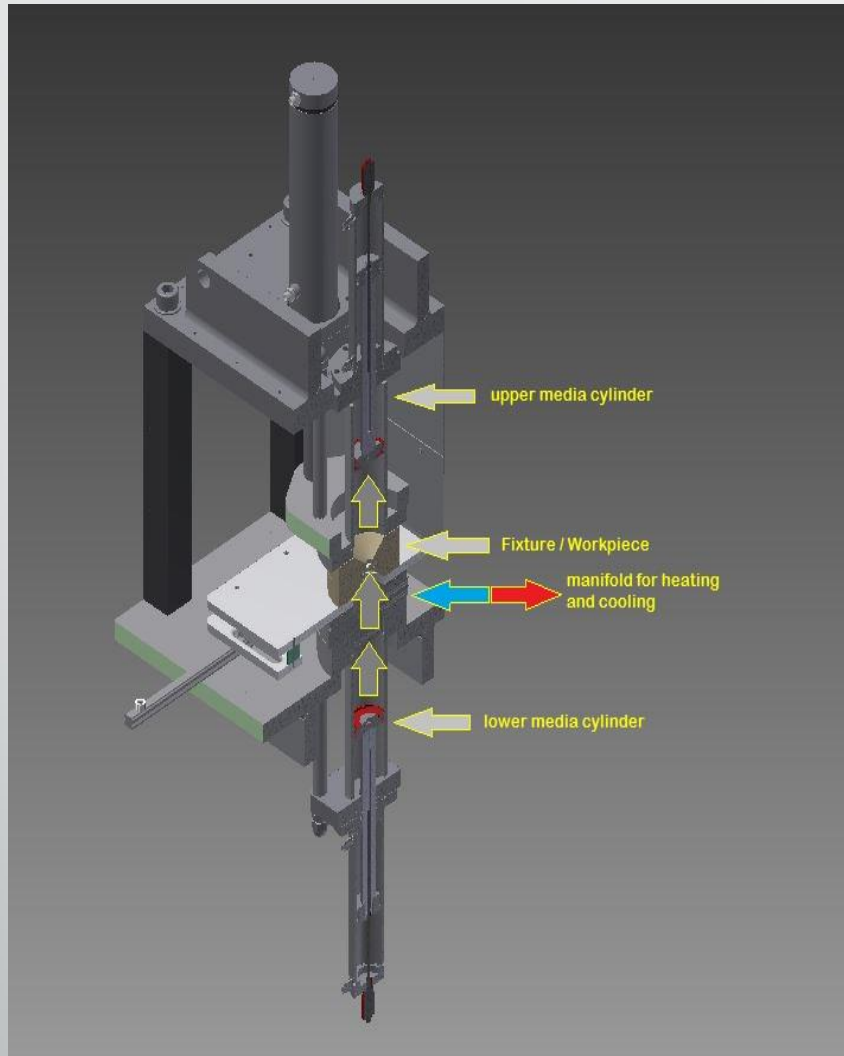
Our main activities

- **Development, manufacturing and sales of AFM machines**
- **Development and manufacturing of fixtures**
- **Development, manufacturing and sales of AFM media**
- **Service and sales of spare parts for all AFM machines - manufacturer-independent**
- **Subcontracting**

AFM: The Process



- The fixture and/or work pieces are placed into the machine.
- The abrasive media is pressed through the work pieces.
- The media is working on all surfaces that it passes.
- Therefore positions in the work piece can be processed that are manually not accessible.



AFM is used for:

Removal of marks from preceding processes regardless if from conventional or from additive machining

- Working on the surface / polishing
 - Improving the surface finish (roughness)
 - Removal of the Recast Layer after EDM (Electrical Discharge Machining)
- Deburring / Edge rounding
 - Removal of burrs
 - Removal of tension peaks by edge rounding

AFM: The Process

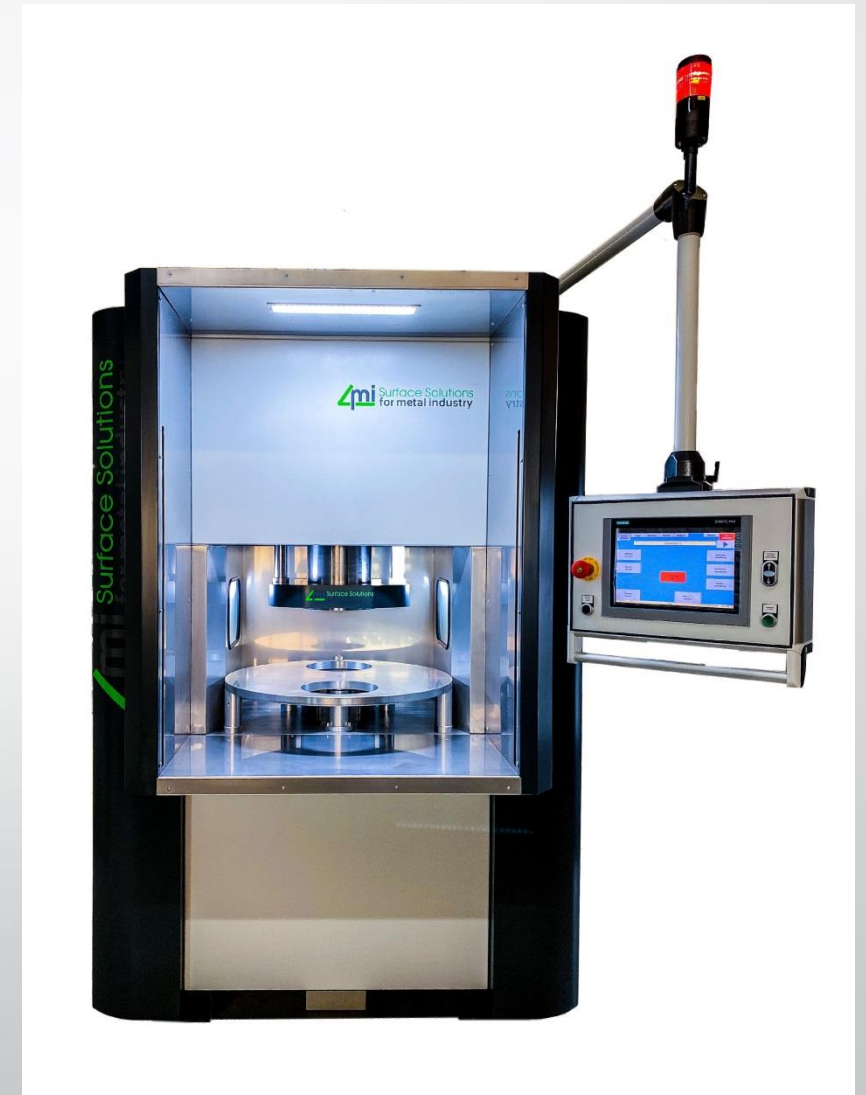
AFM allows to design an automated production flow process and therefore to increase repeatability.

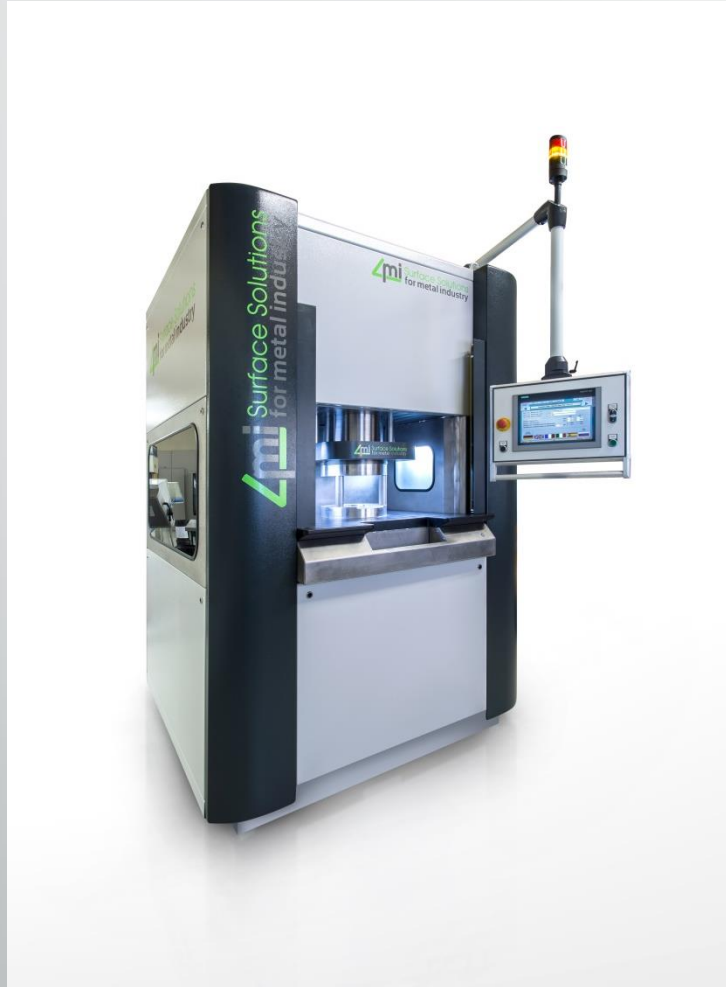
AFM is ideal for internal surfaces.

Surface roughness up to $Ra = 0.01 \mu m$ is possible.

The processing result is always dependent on the initial work piece condition.

Smallest machinable diameter ca. 0.5 mm





The AFM machine is the first of the three mainstays of the AFM process.

Tasks of the machine:

- Clamp and seal the work piece / fixture
- Press the abrasive media through the work pieces
- Temperature control of the media
- Process control
 - Pressure
 - Temperature
 - Media flow speed
 - Number of strokes / media displacement
- Monitor maintenance intervals
- Work piece data base



- Different machine models for different requirements:
Vision / Center / Nano / Production / Elementary
- AFM machines for specific applications:
For example the *Co-Flow-Machine* for 1-way-flow AFM with continuous media feed
- Customized machines

AFM: The Abrasive Media

The Abrasive Media is the second mainstay of the AFM process

It is a polymeric, highly viscous material comprising abrasive grit.

The properties of the media are tailored according to the respective application.

The properties of a given media are determined by:

- Viscosity
- Abrasive material (Silicon Carbide, Boron Carbide, Diamond Powder)
- Size and quantity of the abrasive
- Additives for certain rheological properties



AFM: The Abrasive Media

Design of individual recipes for different work pieces and different specifications.

We are measuring the viscosity of all intermediate and final products.

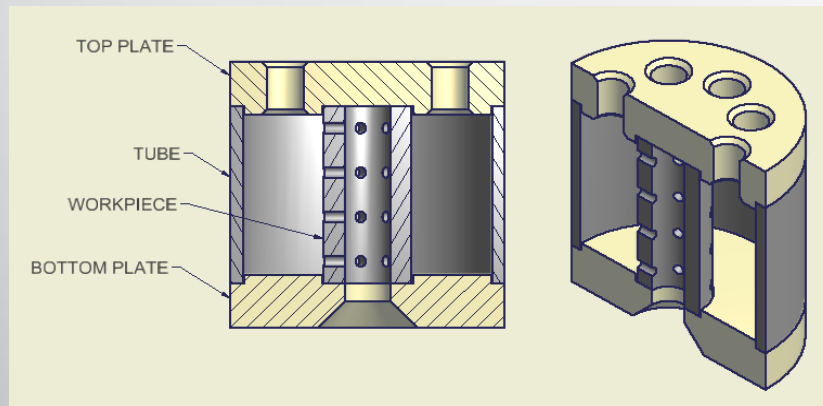


AFM: Fixturing

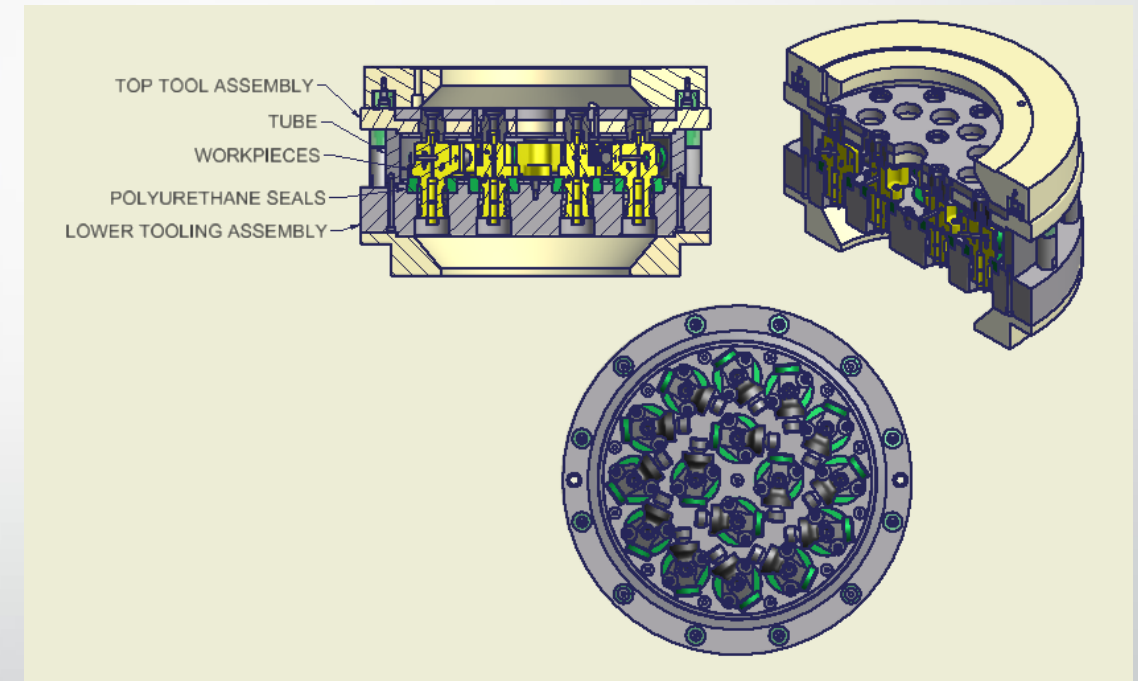
The fixture is the third mainstay of AFM.

Tasks:

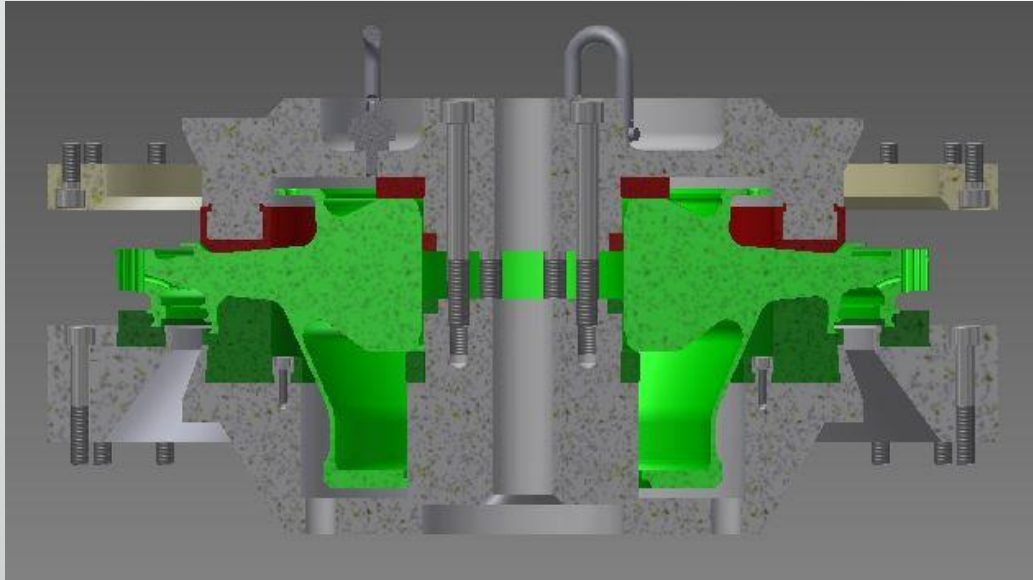
- The fixture holds the work piece
- It leads the media to the respective spot



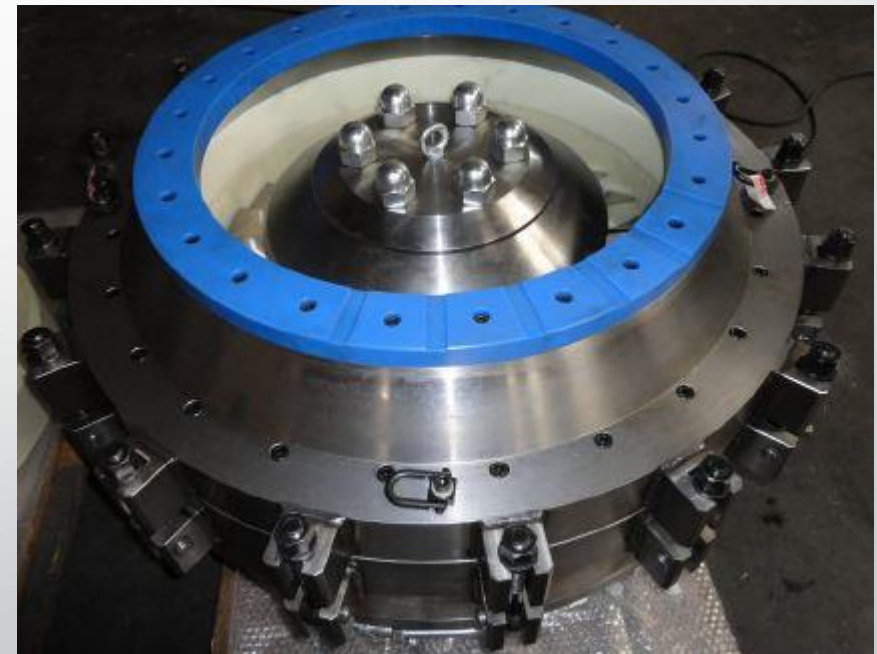
Single-part-fixture



Multi-part-fixture



Fixtures for processing turbine discs



AFM: Cleaning after the process

1. Primary cleaning with compressed air
2. Treatment with a liquid cleaning agent

Water based or hydrocarbon based

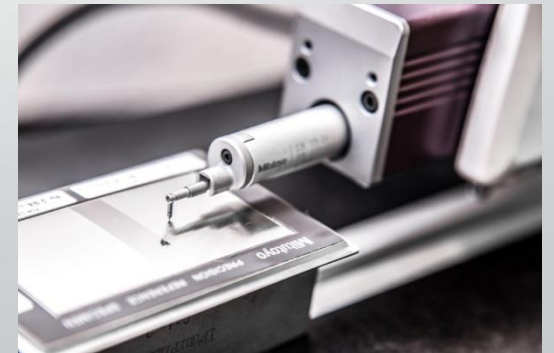
Typically with ultrasonic support

3. Cleaning a second time with compressed air for final cleaning and drying





- Our team has decades of experience in AFM
- Best process repeatability and practice
- Cost-effectiveness
- Any lot size: 1 or more
- Quick turn-around
- 4mi GmbH is certified to ISO9001:2015
- Incoming, in-process and final work piece inspection



before AFM



Stator,
produced by
additive
manu-
facturing

after AFM



Turbine discs:
Polishing of the blades
by AFM

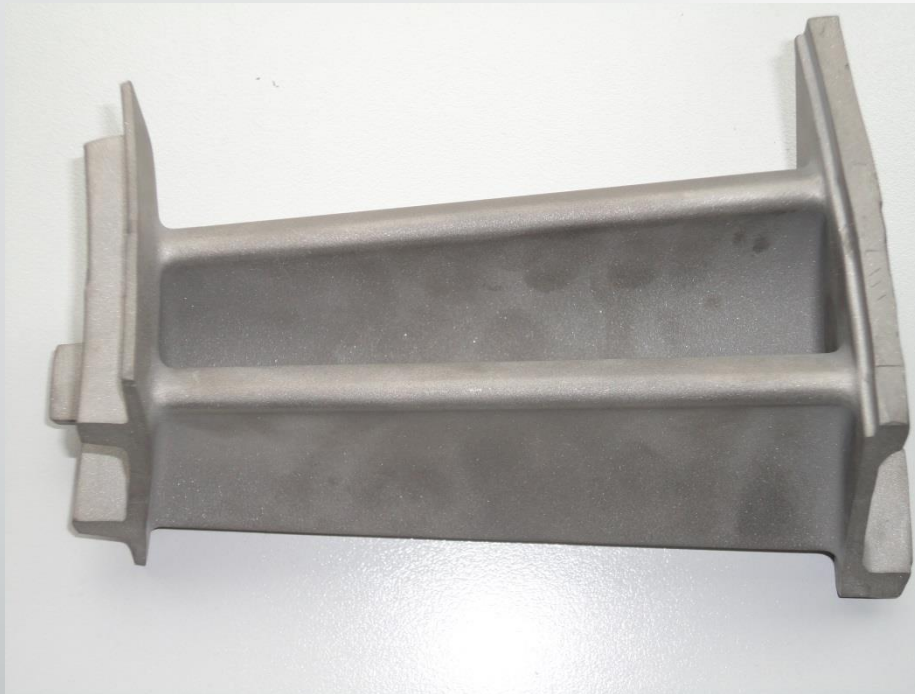




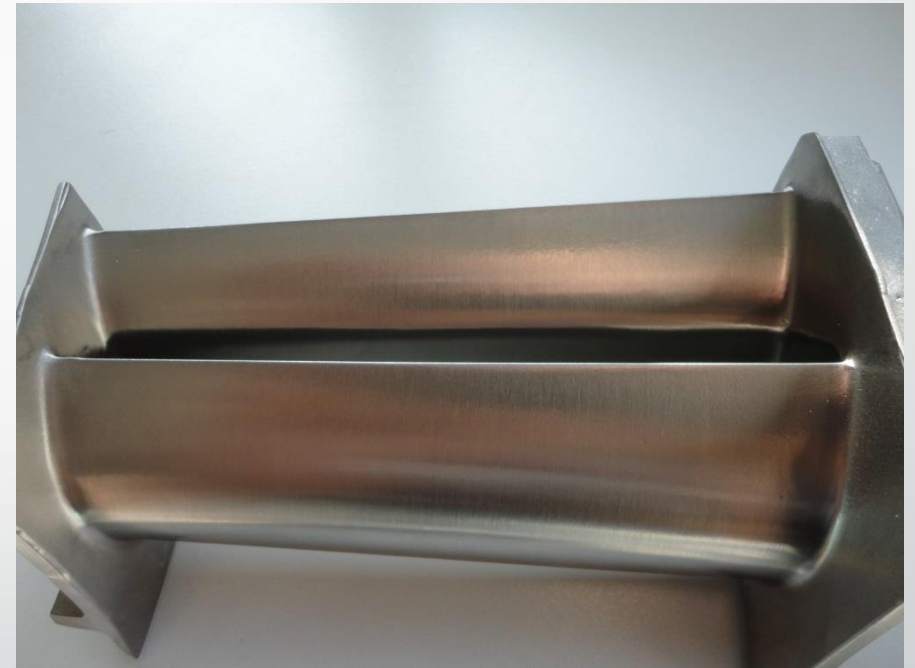
**Edge generation
of the fir tree feature
of turbine discs**



Turbine blades



Before AFM



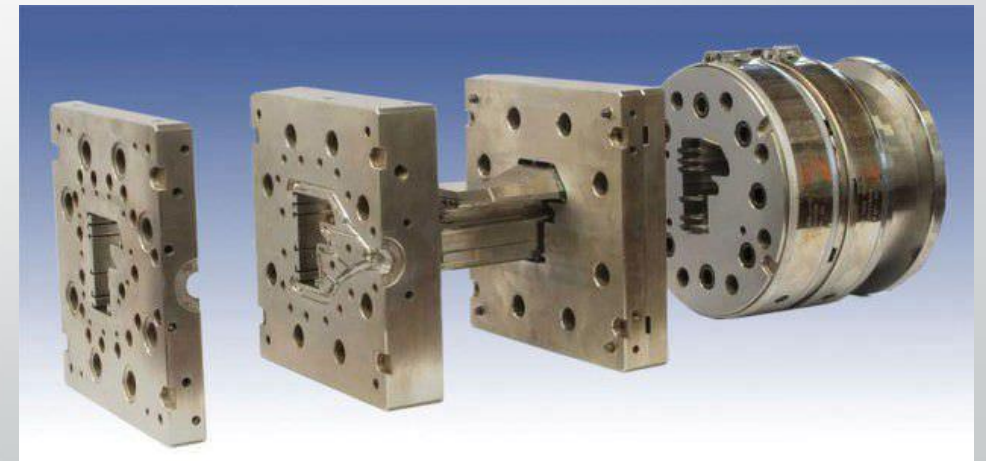
After AFM

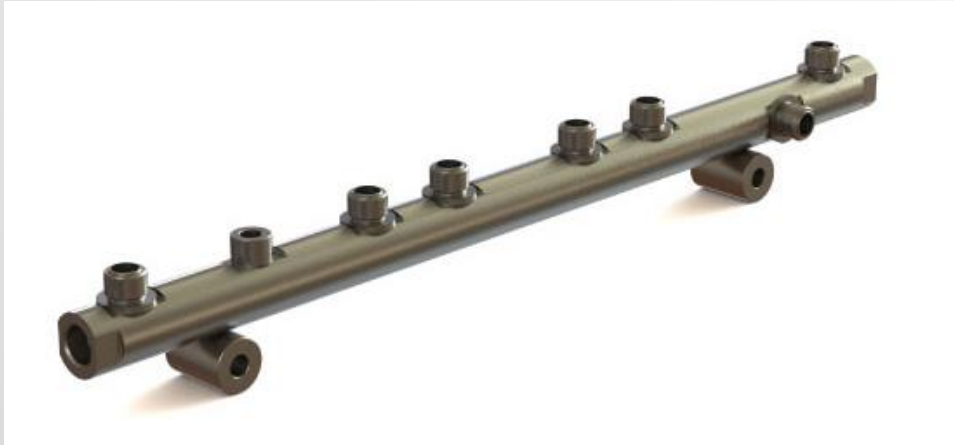
Aluminum Extrusion dies



- Automated process
- High repeatability
- Quicker and more reliable than manual polishing
- No fixture needed

Plastic Extrusions dies





Edge generation of intersections in injection nozzles, common rails and other injection components



Valve Seat



Before AFM

After AFM

Bone Nails



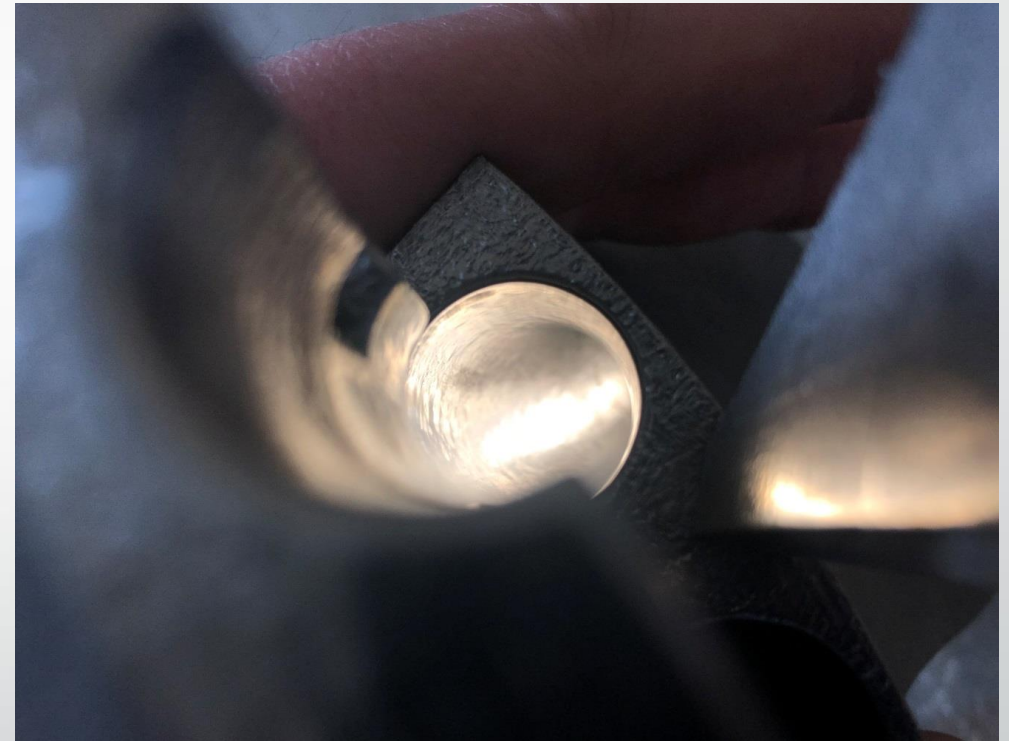
Implants for Fracture Fixation



Flume, produced by Additive Manufacturing



before AFM



after AFM

**Hydraulic
Control Cylinder**



Before AFM

After AFM

**Polishing of connectors
for semiconductors'
industries**



**Mixing Components,
produced by Additive
Manufacturing**



Before AFM

After AFM

**Filter Inserts,
produced by Additive
Manufacturing**



Before AFM

After AFM

Thank you for your attention!

Please visit our booth #623